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Beam deflection applied to Neutral Beam Injection for a Fusion Devices reactor

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An innovative scheme of a neutral beam injector (NBI), based on the electrostatic acceleration and magneto-static deflection of negative ions, suitable for DEMO-like fusion reactor, is proposed and analyzed in term of feasibility and performance. The scheme is based on the deflection of a high energy 2 MV and high current (some tens of Amperes) negative ion beam by a large magnetic deflector placed between Beam Source (BS) and neutralizer. This scheme has the potential of solving two key issues concerning the operation of neutral beam injectors for a fusion reactor: the maximum acceleration voltage and the direct exposure of the Beam Source (BS) to the neutron flux from the fusion reactor. A beam deflection of 45 degrees has been applied as it is sufficient to screen the BS from the neutron flux therefore allowing the electrostatic accelerator to be insulated from the grounded vessel by compressed SF₆. The latter is essential to obtain a stable injector performance at higher accelerating voltages. The scheme has been analyzed from the point of view of the beam optics in order to ensure the divergence is within acceptable values and it has been found that the scheme is quite effective as the deflector is able to guarantee, not only the steering effect, but also the necessary beam aiming.